S
333.7
E13me11
1977

3G19:77N02(11)

The Montana Energy and MHD Research and Development Institute, Inc.
Post Office Box 3809
Butte, Montana 59701
(406) 494-4569
FTS 585-2421

Montana State Library
3 0864 1004 5826 7

MONTANA ENERGY CONSERVATION PLAN

Working Paper No. 11

DIRECT COAL COMBUSTION

STATE DOCUMENTS
JUL 15 77

A Report to the

Montana Energy Advisory Council

John R. McBride
Environmental Systems Specialist
The Montana Energy and MHD Research and Development Institute, Inc.
Butte, Montana

January 1977

INTRODUCTION

In the past century, world energy consumption has become almost totally dependent on fossil fuels. The United States and the rest of the world recently discovered that this dependence can result in severe economic dislocations since the reserves of fossil fuels are not distributed evenly over the globe. Even more severe economic dislocations can be expected in the future since fossil fuel reserves also are finite, and oil and gas reserves in particular are being consumed rapidly.

The geopolitical implications of fossil fuel dependence are evident--particularly in Montana. Montana receives over 40 percent of its natural gas supplies and a considerable quantity of crude oil from Canada. These supplies are being curtailed gradually and are scheduled to be eliminated completely in the 1980's. Montana also produces natural gas and crude oil which are exported to other states and similarly imports natural gas and crude oil from adjacent states. The implications of Montana's petroleum and natural gas supply situation are becoming appreciated widely within the state and industries, and individuals are beginning to search for alternative fuels.

Coal is an alternative fuel which currently is receiving considerable attention. Coal is a solid with a gross chemical composition of carbon, hydrogen, oxygen, nitrogen, sulfur, and inorganic constituents which generally are ash forming. The heating value of coal ranges from approximately 6,000 Btus per pound for low grade lignite to over 14,000 Btus per pound for high volatile bituminous coal. Montana coal can be characterized generally as lignite or subbituminous with a heating value

of 6,500 to 9,500 Btu's per pound. A simple chemical formula for Montana subbituminous coal would be

$$COAL = CH_{0.9}O_{0.2}S_{0.004}N_{0.01} + ASH + MOISTURE.$$

It can be seen from the above chemical formula that coal is not a pure hydrocarbon. Both coal's solid state and impurities can lead to difficulties in utilization: underground coal mining can lead to occupational health and safety problems. Strip mined land is often difficult and occasionally almost impossible to reclaim. Coal can be highly polluting when conbusted directly, and the environmental and occupational health and safety problems related to coal liquefication and gasification are not insignificant. Also, coal's solid state imparts additional difficulties and costs associated with transportation, storage, and handling. Despite these difficulties, there recently has been increased national emphasis on the expanded use of coal as an energy source. It is ironic (in a sense) that the United States is turning toward increased utilization of coal and viewing it as a "new alternative source of energy. In actual fact, coal was the primary fuel for the industrial revolution in Europe and America. In 1889, 87 percent of United States energy consumption came from coal, and as late as 1948, over 46 percent of United States energy still came from coal.[1] For comparison, approximately 18 percent of United States energy currently comes from coal, and most of this is used for generating electricity.[2]

The United States does have large known unexploited reserves of coal. Approximately 25 percent of these reserves happen to be located in Montana.[3] The Montana Bureau of Mines and Geology estimates that over 50 billion tons of strippable lignite and subbituminous coal are located in parts of eastern

Montana.[4] The location and extent of Montana's coal reserves are shown in Figures 1, 2, and 3. In 1975, Montana produced over 22 million tons of coal. By 1980, coal production in eastern Montana may approach 40 million tons per year.[5] Currently, there are five large operating strip mines in eastern Montana, and two more mines may be in operation by 1980. A few small coal mines which supply coal for local consumption also operate in eastern Montana.

In addition to the existing and planned strip mine operations, there is also considerable coal leasing activity in eastern Montana. According to the Northern Plains Resources Council, over 601,000 acres of land were under lease by 47 individuals and corporations in 12 counties of eastern Montana as of March 1, 1973. Major coal lessors include the United States Government through the Bureau of Land Management, the State of Montana, the Crow and Northern Cheyenne Indian tribes, and the Burlington Northern Corporation. The Bureau of Land Management is currently in the process of selecting additional land in eastern Montana for coal leases.

Montana's coal reserves obviously are enormous; in fact, they represent 99.8 percent of all of the state's fossil fuel reserves.[6] In 1975, Montana consumed 270 trillion Btus of energy, 83 percent of which was natural gas or petroleum products. Coal represents 10 percent of Montana's energy consumption, with the remaining energy being supplied through hydroelectric generation. Coal can be gasified or liquefied to produce synthetic liquid and gaseous fuels. Direct coal combustion also could substitute for some current uses of natural gas and petroleum products. In fact, one could hypothesize that all of Montana's oil and natural gas consumption could be replaced by coal.

If this event were to occur, Montana would need to produce (for its own use) about 25 million tons of coal per year at current energy consumption levels. Thus, Montana could supply its current level of energy consumption from coal and existing hydroelectric generation for at least 2,000 years from its strippable coal reserves.

Unfortunately, one could argue that the United States also could supply all its petroleum and natural gas consumption from synthetic fuels derived from coal. Hence, coal should not be viewed under any circumstances as a long-run solution to our energy problems. Coal reserves are just as finite as those of petroleum and natural gas. If the United States replaced our current consumption of petroleum and natural gas with coal derived synthetic fuels and, in addition, increased the direct combustion of coal, those enormous reserves would be consumed rapidly, likely within a century or less. Coal has an important role in our energy future; however, it should be viewed as a transition fuel to be used wisely and efficiently to bridge the gap between our current energy situation and our non-fossil fueled energy future. One should realize that every pound of coal consumed now will be unavailable for use in the future as a hydrocarbon feedstock to produce plastics, pharmaceuticals, and other important societal needs.

This report deals specifically with the direct combustion of coal. Liquefaction and gasification are reviewed elsewhere. The focus of this report is on the possibility of more efficient coal-fired electrical generation and on the substitution of coal for other more scarce fossil fuels for industrial and residential use as a heat source or boiler fuel. Hence, direct coal combustion can be studied logically for both centralized and decentralized applications.

Source: Project Independence Blueprint
Federal Energy Administration
U.S. GPO, Washington, D.C.

Figure 1.--Identified Coal Resources--Upper Midwest Region

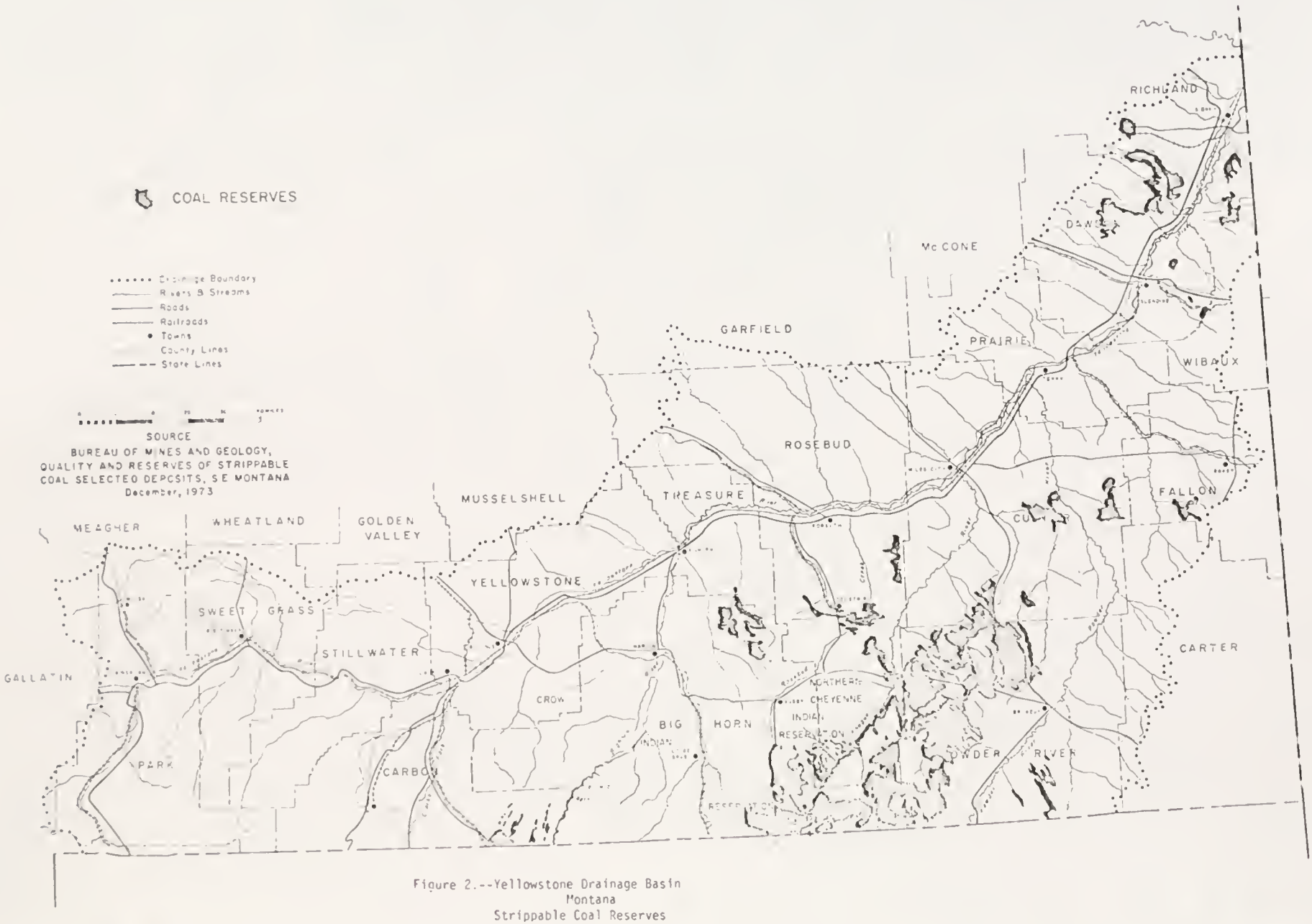


Figure 2.--Yellowstone Drainage Basin
Montana
Strippable Coal Reserves

(million short tons)

Coal Supply Area	Coal District Coverage	State	Class of Coal	Reserve Base*		Analytical Data**											
						Moisture** (As Received)			Ash** (Dry)			Sulfur** (Dry)			B.T.U.** (Dry)		
				Total	Strip	High	Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean
	19	Idaho	Bit.	---	---	9.0	4.9	6.2	9.9	4.7	6.3	1.8	0.8	1.1	13530	12700	13320
	22	Montana	Bit.	1,384.02	---	15.4	2.4	8.5	24.5	4.1	10.6	5.8	0.3	1.3	12880	10320	12220
			Sub.-Bit.	99,211.94	35,430.93	28.7	8.0	14.8	28.8	3.7	11.6	5.7	0.3	1.1	12700	9360	11650
			Lignite	7,131.00	7,131.00	44.0	29.0	33.8	17.1	7.0	9.7	4.1	0.2	0.6	11420	10060	11160
	21	North Dakota	Lignite	16,003.00	16,003.00	48.3	21.3	35.1	34.5	5.6	10.5	4.6	0.2	0.7	11640	7760	10860
5	21	South Dakota	Lignite	428.00	428.00	38.5	29.8	35.1	22.7	2.5	12.2	2.6	0.5	1.0	11410	9490	10840
	19	Wyoming	Bit.	4,524.03	---	28.6	2.4	12.0	21.2	1.4	5.8	9.0	0.2	0.7	13600	11040	12900
			Sub.-Bit.	46,703.77	23,673.93	32.8	12.1	22.7	16.5	2.2	5.8	2.7	0.2	0.6	12720	10500	12310
	19,21,22	Total	Bit.	5,908.05	---	28.6	2.4	11.6	24.5	1.4	7.8	9.0	0.2	0.8	13600	10320	12770
			Sub.-Bit.	145,915.71	59,104.86	32.8	8.0	20.8	28.8	2.2	6.3	5.7	0.2	0.6	12720	9360	12250
			Lignite	23,562.00	23,562.00	48.3	21.3	35.1	34.5	5.6	10.5	4.6	0.2	0.7	11640	7760	10870

* Measured and Indicated, 0 - 1,000 ft., ≥ 28" for Bit., ≥ 60" for Lignite and Sub.-Bit., represents 100% of the coal in place.
** Raw Coal.
Data Source: U.S. Bureau of Mines MERIT System.
Prepared June 1974.

Source: Project Independence Blueprint
Federal Energy Administration,
U.S. GPO, Washington, D.C.

Figure 3.--Northern Great Plains Coal Reserve Base

CENTRALIZED COAL FIRED GENERATION

Centralized direct coal combustion currently is used primarily to generate electricity. Coal is burned to raise steam which powers turbines and generates electricity. Recent trends have been to construct large coal-fired electrical generating stations at relatively remote locations. For example, if and when the Colstrip III and IV electric generators are constructed, a total of 2,060 MW of electrical generating capacity will be located at Colstrip, Montana (over 100 miles southeast of Billings and several hundred miles from the prime electrical load centers that the plant serves). The energy conversion efficiency of a large modern coal-fired electric generator is likely to be about 35 percent.

There are two ways in which energy can be conserved in centralized coal-fired electrical generation: the conversion efficiency of the process can be increased or more waste heat (a by-product of electrical generation) can be utilized effectively.

Fluidized bed combustion, a new alternative process for direct coal conversion, currently is under development and holds high promise for increasing the efficiency of direct coal combustion in the future. Fluidized bed combustion is undertaken in an inert bed of coal ash and crushed limestone which rests on a bed of nozzles. Combustion air enters the bed through the nozzles, expands the bed, and causes it to flow much like a liquid. Combustion is accomplished by introducing crushed coal and raising the bed to the ignition temperature of the coal. Volumetric heat release rates for fluidized bed combustion are on the order of 10 times those of conventional pulverized coal furnaces. Heat transfer surfaces are placed within the bed itself to absorb at least half of the heat released; the

remainder of the heat released is collected by conversion surfaces. The combustion temperature of the bed is controlled at 1600 to 1800°F, considerably lower than conventional coal combustion. Since this combustion temperature is below the ash fusion temperature of coal, fluidized bed boilers can be designed independent of the type of coal used. A generalized schematic of a fluidized bed boiler is shown in Figure 4.

One of the major attractive features of fluidized bed combustion is its potential for air pollution emission control. Emission control is inherent in the fluidized bed combustion process. If limestone is injected into the fluidized bed, the bed turbulence will promote the reaction of sulfur dioxide with limestone and effectively remove sulfur from the system as dry calcium sulfate. Studies on the potential for limestone regeneration are underway currently.[7] The relatively low combustion temperature in the fluidized bed combustion process also limits the formation of oxides of nitrogen as does the minimum of excess air required for combustion.

While there are no fluidized bed boilers commercially available in the United States today, the Pope, Evans, and Robbins Company of Alexandria, Virginia, has done considerable pre-commercial development of fluidized bed combustion systems.[8] Also a 30 MW pilot fluidized bed boiler recently was built in Rivesville, West Virginia, and currently is beginning to undergo testing.[9] The Foster-Wheeler Company, manufacturer of some of the components of the Rivesville plant, indicates that they will warrant units of comparable size after 6 months of successful operation.

If this plant is successful, a scale up to 800 MW could take place by the early 1980's.[10] Fluidized bed electrical generating plants could be in

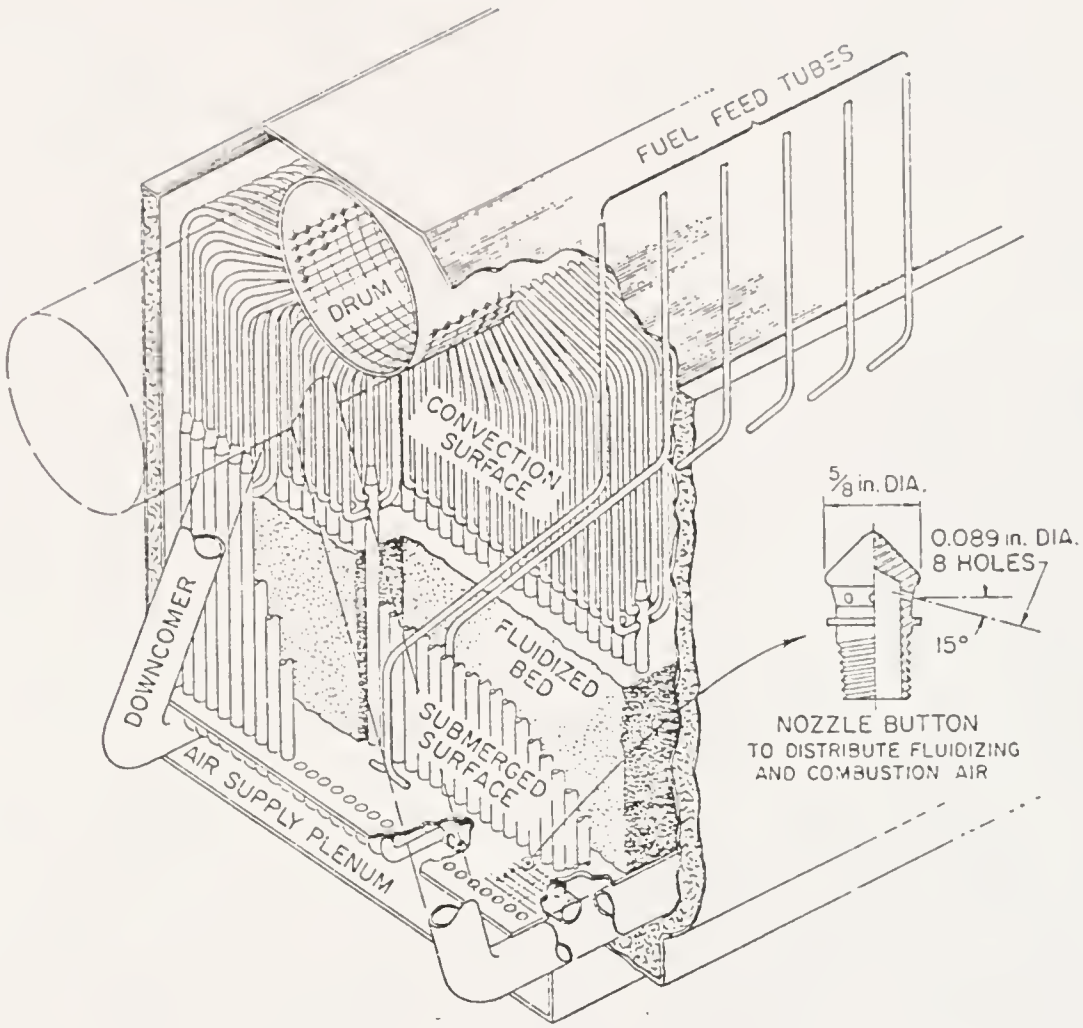


Figure 4.--Schematic of a Fluidized Bed Boiler

Source: T. O. Anderson, et. al., "An Assessment of Industrial Energy Options Based on Coal and Nuclear Systems." Oak Ridge, Tennessee, Oak Ridge National Laboratory, July 1975.

commercial operation in the period 1980 to 1985 and utilized widely after 1985. One recent report estimates that the capital costs of fluidized bed boilers will be $250 to $300/KW with operating costs of 2 to 3 mills/KW.[11]

These cost figures are substantially less than conventional coal-fired steam electric generation with flue gas desulfurization. However, more recently the Electric Power Research Institute estimated that atmospheric fluidized bed combustion would produce electricity with a busbar cost equivalent approximately to conventional coal-fired generation with a scrubber system.[12] Fluidized bed combustion also is more efficient than combustion in conventional coal-fired boilers because of both reduced power consumption for pollution control and increased heat transfer rates. If fluidized bed combustion proves to be as pollution free, cheap, and efficient as preliminary data indicate, it should be utilized widely. Some potential drawbacks of the process are sorbent availability (i.e., limestone), spent sorbent disposal ($CaSO_4$), and higher cost particulate removal.

Magnetohydrodynamics (MHD) is a process in which fuel (coal) is combusted at extremely high temperatures and seeded with an ion source; the hot ionized combustion gases then are passed through a magnetic field to produce a direct electric current. The MHD process is more efficient than conventional steam generation; in fact, the hot combustion gases can be used to power a conventional boiler after they have passed through the MHD channel. Thermal efficiencies in the neighborhood of 55 percent are expected from the MHD process. Sulfur pollution also is reduced or eliminated in the MHD process. A coal-fired MHD research facility currently is being constructed in Butte, Montana, and an expanded engineering test facility is scheduled to be built in Montana in the 1980's. However, the process will not be available

commercially in the near future. An enormous amount of research must be conducted before the commercial feasibility of the process can be explored.

Energy also can be converted more efficiently by increasing the utilization of the heat by-product of electrical generation. If steam electric generating facilities were located close to industries or cities, the steam produced to generate electricity also could be used for industrial applications and/or residential/commercial heating. Such applications are commonplace in Europe.[13] Electrical generation facilities would have to be scaled more to the needs of the direct locality to utilize the steam effectively. This is in contrast to the current trend toward large scale central generation. Air pollution control also would have to be implemented strictly. However, the potential energy conservation benefits of decentralized electrical generation are large enough to warrant detailed examination.

In past years, coal also was combusted directly to raise steam for district heating without actually generating electricity. This centralized direct coal combustion application has fallen into disuse in the United States and appears unlikely to be revived. The benefits of the cogeneration of electricity and process steam appear to eliminate the viability of direct coal combustion steam heat.

DECENTRALIZED COAL COMBUSTION

Decentralized coal combustion can have considerable applicability in Montana for both industrial and residential use. Again, conventional coal combustion and fluidized bed combustion both are applicable.

1. Industrial Direct Coal Combustion

The direct combustion of coal as a substitute for natural gas is an alternative that several industries in Montana recently have turned to. In April 1976, the Ideal Cement Plant at Trident, Montana, converted from natural gas to coal at a capital cost of $2.3 million, or approximately $1.20 per million Btus of annual consumption converted to coal. The Kaiser Cement Plant near Helena, Montana, has a similar conversion to coal planned at a capital cost of $1.5 million (~$.90/million Btus) of annual consumption converted. Finally, the Great Western Sugar Company in Billings, Montana, has announced plans to convert to coal as an energy source for their sugar beet processing plant. The capital cost of this conversion is reported to be $3.21 million (~$2.70/million Btus) of annual consumption converted. Air pollution control costs for this facility are over $1.2 million. As can be seen above, the capital costs of conversion to coal from natural gas are highly variable depending upon the particular industrial facility considered. Normalized conversion costs also vary inversely with the size of the facility converted. Fuel costs for coal delivered in Montana vary with location. Reasonable fuel cost (1975 dollars) estimates for Colstrip, Montana, coal delivered to various Montana cities in very large industrial quantities are Butte ($.70/ million Btus); Missoula ($.80/million Btus); and Billings ($.50/ million Btus).[14] These coal fuel costs certainly are favorable when compared to natural/synthetic gas. Coal fuel costs do not seem likely to escalate rapidly in the future either.

Coal-fired boilers currently are available utilizing spreader grate, cyclone furnace, or pulverized coal firing.[15] Spreader grate boilers can be employed up to about 0.4×10^6 lb of steam per hour; however, the sized coal required for spreader grate operation may not be available readily. Both boiler design and cost are particularly sensitive to the specific type of coal to be used. The Oak Ridge National Laboratory estimates that the

annual cost of coal-fired steam generation using western coal (8500 Btus/lb, 0.5%S) to be $1.53/million Btus. They also estimate that flue gas cleaning processes are available for ~$.50/million Btus additional. The Oak Ridge estimate is split almost equally between capital and fuel costs.

The favorable economics of direct coal combustion is contrasted by its unfavorable environmental impact. Even with the "best available" air pollution control equipment, a coal-fired boiler will emit more pollutants than a conventional gas-fired boiler. As previously noted, a significant portion of the cost of coal-fired boilers will be allocated to air pollution control. Although direct coal-fired combustion (with proper pollution control) appears suitable for areas with adequate pollution dispersion potential, there are certain areas within the state (particularly in western Montana) where conventional coal combustion simply may be unacceptable environmentally.

Fluidized bed coal-fired boilers may offer environmental and possibly economic benefits for industrial use. As was noted previously, a 30 MW fluidized bed boiler currently is undergoing tests in West Virginia. Similar boilers may be available commercially in the United States as soon as next year. The city of Linkoping, Sweden, currently is evaluating bids from several vendors to build a 15 MW boiler for its district heating system; hence, at least intermediate-sized fluidized bed boilers must be available in Europe.[16] Fluidized bed combustion can be utilized for most industrial applications that could use conventional coal-fired generation.

Cost data for fluidized bed boilers are not fully developed yet in the United States. In 1970, Pope, Evans, and Rogers estimated that a fluidized bed boiler would cost approximately 1.4 times that of an equivalent gas-fired boiler, while a conventional spreader grate coal-fired boiler would cost 2.35

times more than a gas-fired boiler.[17] Oak Ridge National Laboratory predicts slightly lower steam costs ($1.65/million Btus versus $1.84/million Btus) for a fluidized bed boiler compared to a conventional boiler with stack gas desulfurization at an equivalent location. The lower costs for fluidized bed combustion are projected because of their more compact, standardized design, their reduced surface area, and the fact that they can be assembled at the factory rather than at the field.

2. Residential and Commercial Direct Coal Combustion

Coal could have considerable potential applicability in the residential and commercial sectors as a substitute for the combustion of other relatively scarce and expensive fossil fuels. Coal was once one of the primary fuels for residential heating in the United States. Unfortunately, its cost, inconvenience, and polluting characteristics essentially removed it from the home energy market. If coal is to return to widespread residential and commercial use, these characteristics (especially air pollution control difficulties) must be overcome. Coal was simply banned from home heating in London in the 1960's as a much warranted air pollution control measure, and the city dwellers of Montana cannot permit the development of London style smog simply for the sake of economic expediency. Direct coal combustion may be suitable for rural residences and businesses; but if coal is to again capture the urban residential and commercial heating market, it must do so on a socially and environmentally equitable basis.

For small residential use, coal still can be purchased for $30 to $50 per ton ($1.66 to $2.77/MM Btus @ 9000 Btus/lb) and can be delivered in many urban areas in Montana. Conventional coal stokers also can be ordered; for example, the Prill Manufacturing Company of Sheridan, Wyoming, distributes

their coal stoker in many Montana cities. Unfortunately, coal furnaces generally are considerably more expensive than gas or oil furnaces. For instance, it appears that a conventional coal stoker with all necessary duct work would cost in the neighborhood of $3,500 to $4,000 for a new house compared with $2,000 for electric resistance heating and $2,500 to $3,000 for oil, gas, or propane. Monthly operating costs for a coal furnace would be significantly cheaper however. On a Btu input basis, coal fuel costs may be one-half that of natural gas and less than 1/6 that of electricity. In any case, the coal delivery system in Montana would have to be greatly expanded, and coal furnaces would have to be much more available before they could recapture a significant share of the home heating market. Even if the environmental liabilities of conventional coal furnaces could be overcome, many people may be reluctant to endure the inconvenience of a traditional coal stoker. Coal-fired home furnaces appear to be an area that would welcome innovation.

A novel fluidized bed combustion furnace for residential and small commercial use currently is being developed by the Montana Energy and MHD Research and Development Institute and Materials Consultants Incorporated.[18] This furnace is ready for refinement and actual testing in Montana. Preliminary data indicate that this furnace has very efficient heat transfer properties, relatively convenient operation, and has more than satisfactory air pollution control characteristics.

This furnace represents a miniturized, shallow fluid-bed system that previously has been unavailable for domestic use. The furnace operates with granular coal which is premixed with limestone to control sulfur oxides. The

bed operates essentially isothermally at a relatively low combustion temperature, thus reducing the formation of nitrogen oxides. Both the input fuel and ash products are handled pneumatically to reduce handling and storage difficulties.

A furnace of this nature would be competitive economically with other fossil-fueled heating systems and could have a large market in Montana. However, the granular premixed fuel will require a coal delivery and ash disposal infrastructure which currently does not exist in Montana.

Bibliography and Footnotes

1. S. B. Clough, European Economic History: The Economic Development of Western Civilization, McGraw Hill Book Company, New York, New York, Revised Edition, 1968.

2. W. G. Dupree and J. A. West, United States Energy Through The Year 2000, United States Department of the Interior, Washington, D. C., December 1972.

3. Terry Wheeling, Montana Historical Energy Statistics, Montana Energy Advisory Council, Helena, Montana, September 1976.

4. Montana Department of Natural Resources and Conservation, Yellowstone Water, Which Way, Helena, Montana, September 1976.

5. Montana University Coal Diamond Study Team, Projections of Northern Great Plains Coal Mining and Energy Conversion Development 1975-2000 A.D.,, Summary Volume, University of Montana, Missoula, Montana, May 1976.

6. R. E. Matson and J. W. Blumer, Quality and Reserves of Strippable Coal, Selected Deposits, Southeastern Montana, Montana Bureau of Mines and Geology, Bulletin 91, Butte, Montana, December 1973.

7. T. D. Anderson, et al, An Assessment of Industrial Energy Options Based on Coal and Nuclear Systems," Oak Ridge National Laboratory, Oak Ridge, Tennessee, July 1975.

8. A. H.Bagnulo, et al, Development of Coal Fired Fluidized Bed Boilers, Volume 1, OCR Report No. 36, Pope, Evans, and Robbins, Alexandria, Virginia, July 1971.

9. Allen L. Hammond, "Coal Research (IV): Direct Combustion Lags its Potential," Science, Volume 194, pp. 173-194.

10. Gilbert Associates, Inc., and Commonwealth Associates, Inc., Status Report: Coal Fueled Advanced Energy Conversion Systems, Reading, Pennsylvania, and Jackson, Michigan, March 1975.

11. Thomas C. Ponder and Lario V. Yerino, "Capital Costs of Sulfur Dioxide Control Systems for Utility Boilers," presented at the Fourth National Symposium, Air Pollution Control Division, American Society of Mechanical Engineers, St. Louis, Missouri, March 1975.

12. ERPI Journal, Volume 1, Number 9, November 1976, pp. 6-13.

13. A. B. Lovins, "Energy Strategy: The Road Not Taken?," Foreign Affairs, pp. 65-95, October 1976.

14. Adapted from Lloyd Berg, Conversion Cost Estimates for the Montana University System, Rough Draft, Bozeman, Montana, September 1975.

15. Babcock and Wilcox, Inc., Steam: Its Generation and Use, Babcock and Wilcox, Inc., New York, New York, 1972.

16. Lovins, op. cit.

17. Pope, Evans, and Rogers, op. cit.

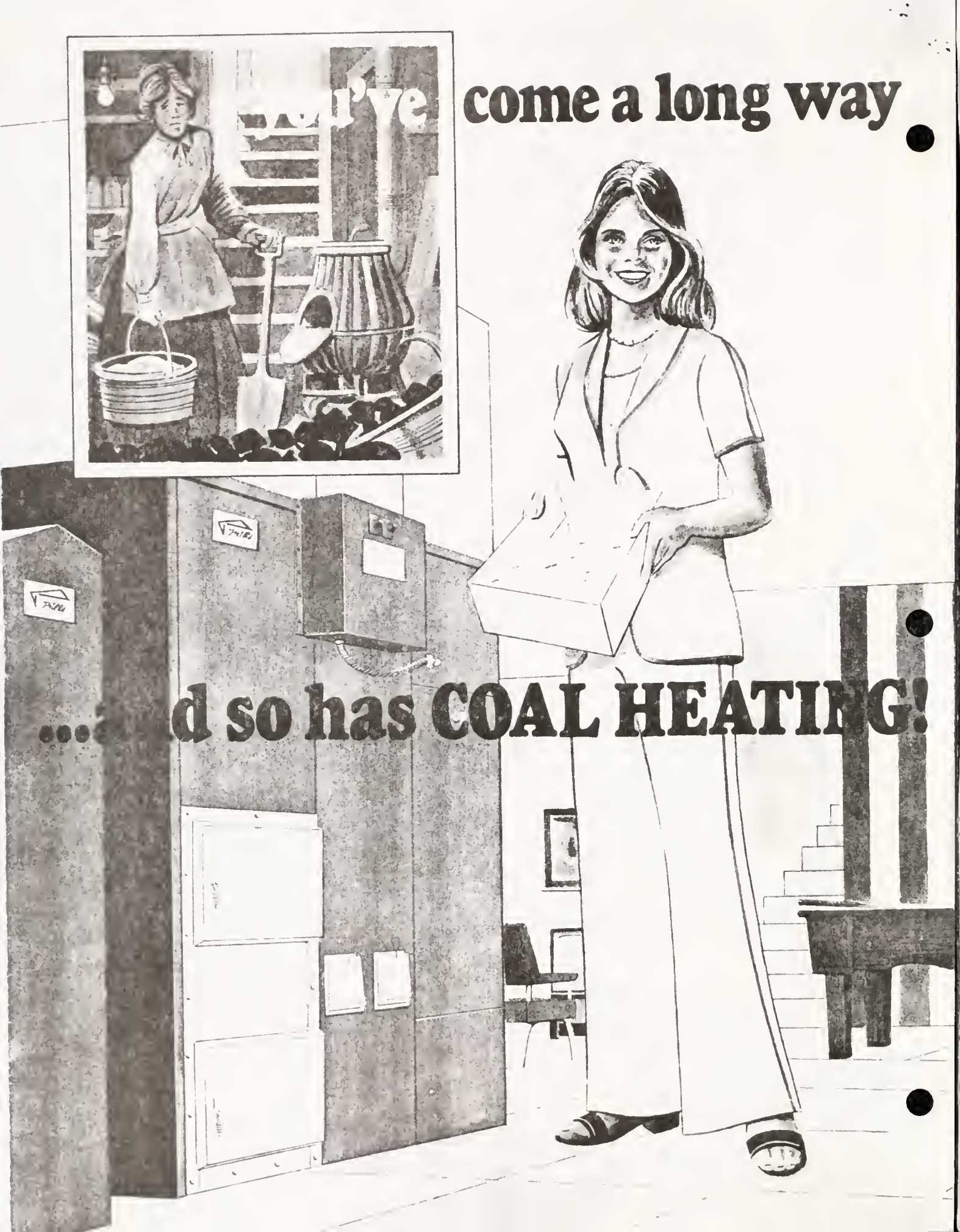
18. Derived from a MERDI research proposal.

19. Federal Energy Administration, Project Independence Blueprint, Government Office, Washington D. C., November 1974.

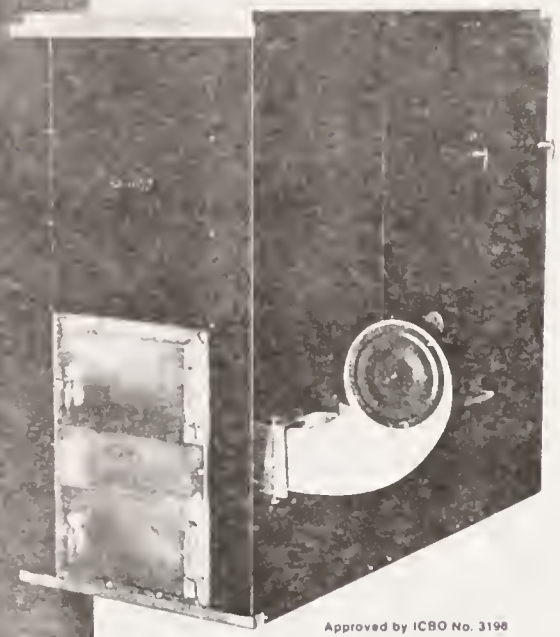
APPENDIX A

Prill Manufacturing Company

Coal Furnace Brochure


come a long way
...d so has COAL HEATING!

now...coal heating is clean, convenient...
...and cheaper than other fuels!



Approved by ICBO No. 3198

● **COAL HEATING COSTS LESS**
Heat all winter for fraction of the cost of propane, fuel oil or electricity. Costs for energy, including heating, are zooming upwards at double figure percentages. But in most areas, where available, coal costs much less. And coal supplies are more stable than most other fuels.

● **COAL HEATING IS EFFICIENT**
Prill's design features make their furnaces much more efficient than old-type coal furnaces. Burner head design controls combustion for more even heat production. Double radiator heat exchanger is more efficient. Prill furnaces are thermostatically controlled for uniform warmth, day and night.

● **COAL HEATING IS CLEAN**
Prill's burner head design prevents clinker build-up. Ashes are removed easily with convenient, slide-out ash pan and can be disposed of as easily as a vacuum cleaner bag. Dust-tight design makes the Prill furnace as clean as any other heating fuel.

COMPLETE HEATING SYSTEMS

With the modern Prill furnace, the homeowner can have total home comfort. Forced-air blower capacity on Prill furnaces is sufficient to add central air conditioning, humidifier, electronic air filter. Prill furnaces take less floor space than old-style coal furnaces. Ducting requirements are the same as for gas or oil fired furnaces, so the Prill coal furnace is ideal for heating unit replacement.

Four models available
Available in 100,000 or 200,000 BTU sizes. Choice of coal hopper or bin-feed models.

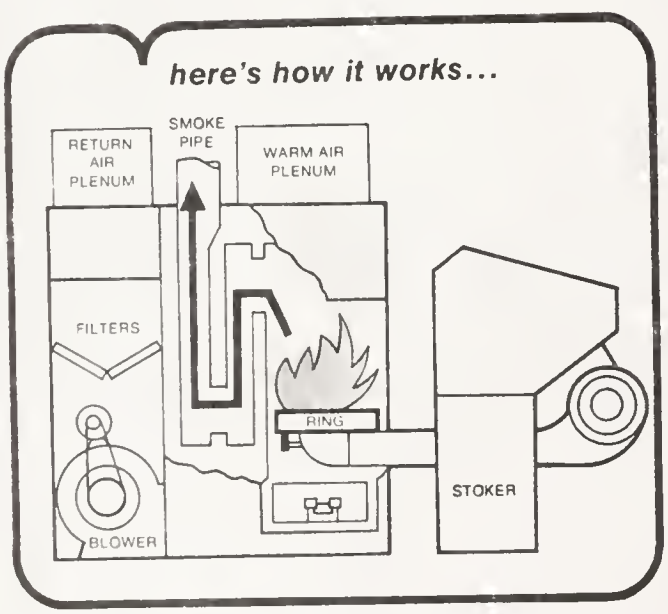
Other innovations from PMC
PMC also manufactures efficient, economical coal fired space heaters, and coal-burning hydronic systems for hot water heat.

Note: Units featured in this brochure are designed to burn lignite and sub-bituminous B coal. Check with factory for burner heads for other types of coal.

PMC CORPORATION

Manufacturers of Prill Automatic Coal Furnaces "New concept in coal heating"

Box 6416, Sheridan, Wyoming 82801 • (307) 672-5801



Features of PMC coal heating units

- No clinker build-up on burner head
- More efficient than most gas furnaces
- More efficient heat extraction from fuel, more efficient heat transter
- Clean burning, dust tight design
- Easy ash removal with slide out ash pan
- Prewired control panel
- Choice of four models and options
- Modern, contemporary appearance
- Fits existing ductwork for convenient replacement of other type heating units

Get in on the growing trend to coal heating.

Prill's AUTOMATIC COAL HEATING

Available from: